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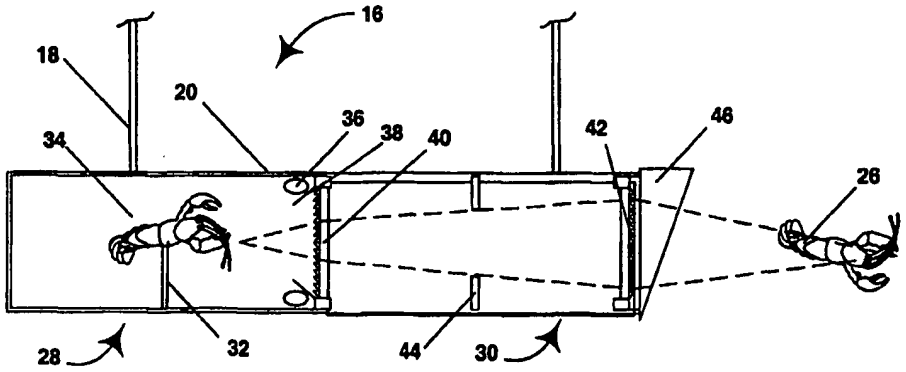

(57) Abstract

An optical projection system for use in advertising in a retail establishment having a housing (20), preferably provided with a mounting device (18) for mounting the housing in overhead space in the retail establishment. An object generating module (28) for projecting an image of an object and a relay module (30) are positioned within the housing. The relay module is arranged to project a real image (26) of the object at a position outside of and spaced from the housing. This real image is arranged to be visible only within a limited area adjacent the housing and at a limited angle of view. The projection system is preferably equipped with one or more loudspeakers and may include a customer input device, such as a touch panel, for changing the real input depending upon the input. A plurality of such optical projection systems may be networked to communicate with a central server and one another for sharing, updating, and controlling applications and data such as images or other advertising messages.

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TITLE: MULTIMEDIA ADVERTISING SYSTEM

Background of the Invention

This invention in general relates to optical projection systems and in particular to an optical projection system which utilizes multimedia technology for use in advertising products in retail environments such as supermarkets or department stores (a term which is used herein to refer to any store, for example, a Walmart®, K-mart®, or Home Depot® store, which carries a wide variety of non-food items, even if such stores are not department stores in the traditional sense).

Retail establishments, especially those large retail establishments, such as supermarkets and department stores, which carry a variety of differing types of goods for sale, make continual use of "point-of-sale" advertising to alert customers to sales, special offers, etc. in each department. Traditionally, such point-of-sale advertising has relied upon printed or similar media, for example, banners, posters, handbills and the like. However, such media provide only static images and are not particularly attractive unless good quality color printing is used; such color printing is expensive, especially since such point-of-sale advertising is changed frequently, often on a weekly basis. Furthermore, in a large supermarket or department store, a single aisle may carry several differing types of goods requiring differing point-of-sale advertising, and the resultant multiplicity of advertising tends to produce unattractive visual clutter which tends to overwhelm customers so much that the advertising gets ingnored altogether.

In an effort to reduce the amount of printed material which must be discarded as point-of-sale advertising is changed and make advertising more attractive to a generation raised on television and video games, attempts have been made to use televisions and video monitors to display point-of-sale advertising. However, large screen televisions and monitors, such as are required in large retail establishments, are expensive, and if several are used in the same aisle, the visual clutter produced by multiple televisions screens, all showing different images, also tends to be even worse than that produced by static displays.

Point-of-sale advertising desirably should be arranged so that the customer is confronted by only one message at a time. In addition, so far as possible, the message should be confined to those customers likely to be interested in a particular product; for example, a customer who does not even bother to check out the seafood bar in a supermarket is unlikely to be interested in a special on lobsters.

Summary of the Invention

The present invention provides a multimedia advertising system including a projection system that operates to form real images of still or animated real or virtual objects such that the real images that are projected are suspended in space forward of the advertising system.

Accordingly, this invention provides an optical projection system for use in advertising in a retail establishment. This projection system comprises a housing; an object generation module disposed within the housing and comprising an object the image of which is to be projected; and a relay module arranged within the housing and comprising an optical system arranged to project a real image of the object outside and spaced from the housing, this real image being visible only from a limited area adjacent the housing and over a limited angle of view.

This invention extends to a retail establishment having a retail area accessible to customers, this retail area being provided with at least one optical projection system of the invention, as defined above.

Brief Description of the Drawings

The structure and operation of the invention, together with other objects and advantages thereof, may best be understood by reading the detailed description in conjunction with the drawings wherein the invention's parts have an assigned reference numeral that is used to identify them in all of the drawings in which they appear and wherein:

Figure 1 of the accompanying drawings is a diagrammatic view of part of a retail establishment equipped with an optical projection system of the invention, and shows the real image produced by this projection system;

Figure 2 diagrammatically shows a side view of the optical projection system shown in Figure 1 with one side wall of the housing removed to show details of the interior construction;

Figure 3 diagrammatically shows a side view, similar to that of Fig. 2, of a second optical projection system of the invention having a reduced housing length, which system can be substituted for that shown in Figure 2;

Figure 4 schematically shows a number of alternative components which can be used in the projection systems shown in Figures 2 and 3;

Figure 5 shows a three-quarter diagrammatic view, from above and to one side, of a third optical projection system of the invention arranged to project two real images in opposed directions;

Figure 6 shows a vertical section, taken along line A-A in Figure 5, of the third optical projection system;

Figure 7 shows a diagrammatic top plan view of a fourth projection system of the invention arranged to project three real images in differing directions; and

Figure 8 shows schematically a fifth optical projection system of the invention which system can be substituted for those shown in Figures 2 and 3.

Detailed Description of the Invention

The diagrammatic supermarket scene of Figure 1 shows part of a typical aisle in a supermarket. The aisle has a floor 10 on which are mounted several display cabinets 12. Within these cabinets 12 are displayed goods 14 offered for sale. In Figure 1, it is assumed that these goods 14 are seafood.

A projection system (generally designated 16) of the present invention is suspended from the ceiling of the supermarket by means of two vertical supports 18, one of these supports 18 being longer than the other so that a cuboidal housing 20 of

the projection system 16 is declined to the horizontal. However, the lengths of the supports 18 are such that all parts of the projection system 16 remain a substantial distance from the floor 10 so that a customer 22 pushing a supermarket cart 24 can walk beneath the projection system 16. The system 16 is capable of forming a real three-dimensional image 26 of, for example, a lobster at a predetermined location in space. The angle of view over which the real image 26 is observable is limited, and its location in space is controllable so that a customer approaching the advertising projection system 16 is presented with the projected image 26 of the lobster when in a predetermined relationship to the advertising projection system 16; otherwise, the lobster image 26 cannot be seen. In practice, the locations and the angles from which the image 26 can be seen will be adjusted so that only customers passing the cabinets 12 containing the seafood 14 will see the image. The system 16 thus makes it possible to control where and what advertising messages are presented to a customer as the customer travels through the retail space architecture; a plurality of systems 16 can be used within a single retail establishment in such a manner that the areas from which the various images produced by the systems do not overlap. Thus, the attention of the customer is focussed on only a single image (and advertising message) at any one time, and unattractive visual clutter produced by a large number of messages visible simultaneously is avoided. This is a significant marketing advantage because it allows appropriate advertising to be done close to a product's point of sale, and avoids a customer being bombarded with a large number of messages at the same time, which tends to cause the customer to "turn off" all the messages.

For retail environments, the advertising system 16 preferably occupies overhead space (as shown in Figure 1) which is not used for other purposes so that the images, such as image 26 in that Figure, are projected down and slightly above eye height where they are easily noticeable and visually accessible without undue neck strain, as indicated by the broken line in Figure 1.

As best seen in Figure 2, the system 16 comprises two major components, an object generation module (generally designated 28) and a relay module (generally designated 30) that preferably operates at 1 to 1 magnification. The object

generation module 28 comprises the hollow rearward (from the customer's point of view) part of the housing 20 and comprises an elongate support member 32, the lower end of which is fixedly secured to the base of the housing 20. A three-dimensional lobster model 34 is fixedly secured to the upper end of the support member 32; it is this lobster model 34 that is imaged to produce the real image 26 shown in Figure 1. The object generation module 28 also comprises light sources 36 which illuminate the model 34; baffles 38 are provided adjacent the light sources 36, so that the light sources 36, which are preferably linear bulbs, illuminate only the object to be imaged (i.e., the model 34) and do not introduce stray light into the projection path. In particular, the baffles 38 prevent light from the sources 36 from impinging directly upon an adjacent Fresnel lens 40, described below.

The relay module 30 preferably comprises, as shown in Figure 2, a pair of identical positive Fresnel lenses 40 and 42 spaced apart by twice the focal length of an individual Fresnel. The Fresnel sides of the lenses 40 and 42 preferably face outwardly, i.e., toward the model 34 and the real image 26 respectively. Each of the Fresnel lenses 40 and 42 is fixedly mounted within the housing 20. Also mounted within the housing 20, substantially midway between the two Fresnel lenses 40 and 42, is a field aperture 44, which serves to restrict the angle over which the real image 26 (Figure 1) can be seen. A light shield 46 is fixed to the end surface of the housing 20 adjacent the Fresnel lens 42 to prevent unwanted reflections from this lens.

Although the object generation module 28 is shown in Figure 2 occupied by a static three-dimensional model 34, it will be appreciated that this module 28 may be occupied by a variety of objects, real or virtual (for example, a screen, such as a cathode ray tube, liquid crystal display or liquid crystal projector on which images can be formed). Such objects may be still, animated, and/or dynamic. The objects in the module 28 preferably are three-dimensional so that the projected images are also three-dimensional. The objects, whether real or virtual, are preferably located in the object generation module 28 so that they occupy the space between the focal plane of the rear Fresnel lens 40 and the Fresneled surface of this lens. The

position of the object within this range of space will control the location of the projected real image.

The scale of the multimedia advertising systems of the present invention can range over any sensible size consistent with the imaging task for any defined retail space. For example, in the system shown in Figures 1 and 2, the Fresnel lenses 40 and 42 might have focal lengths of 30 inches and be rectangular shape, 20 X 30 inches,so that the real image 26 is large and appears several feet forward of the projector system

The optical projection systems of the present invention preferably have their longitudinal magnification M_L equal to their transverse magnification M_T^2 to provide 1:1 imaging. A major advantage in operating at 1:1 conjugates, or nearly so, is that the projected image is virtually undistorted thereby producing very high quality three-dimensional effects which mimic holograms, but without their color rendition, manufacturing, and display problems. However, other magnifications may be used. For example, in large retail spaces, it may be desirable to use magnifications substantially greater than 1:1 in order to provide large, attention-grabbing real images from modest-sized optical projection systems. Alternatively, a system using a magnification substantially greater than 1:1 could provide a real image of substantial size using a very compact optical projection system; thus, it is be possible to conceal the projection system within a false ceiling of the type common in retail establishments, so that the customer would be intrigued by seeing a real image floating in space without any visible projection system.

Figure 3 shows an alternative geometry for the projection system. The system shown in Figure 3 is generally similar to that shown in Figure 2, but has been folded through the use of a pair of 45°-mirrors located between the Fresnel lenses. More specifically, in the system of Figure 3, the object generation module 28' is reversed as compared with the corresponding module 28 shown in Figure 2, and the light which passes through the rear Fresnel lens 40 impinges upon a first mirror 48, located within a relay module 30'; this mirror deflects the light downwardly through a right angle so that the light passes through the field aperture 44 and impinges upon a

second mirror 50, which deflects the light through a further right angle into a path parallel to but in the reverse direction from, the path which the light followed from the object 34 to the first mirror 48. This architecture converts a relatively long advertising system shown in Figures 1 and 2 into a shorter, but taller system while reversing the direction of the projected image. Note that the system shown in Figure 3 is well-adapted for concealment of the bulk of the system within a false ceiling or the like; for example, the system could be mounted so that only the portion thereof below the line 52-52 in Figure 3 is visible below the false ceiling or other horizontal surface. Also, note that the system shown in Figure 3 can be modified by rotating the second mirror 50 and the adjacent Fresnel lens 42 a few degrees counterclockwise (in Figure 3), thereby enabling the desirable downward projection of the real image 26 (cf. Figure 1) to be achieved while allowing the main portion of the system to be mounted horizontally.

Figure 4 illustrates a number of other sources for objects that can be used in place of the model 34 shown in Figures 2 and 3 to generate images for projection. Real (2 and 3-D) objects may be in the form of physical, still or animated (dynamic) objects, as shown at 54 and 56. The animated objects may be provided using robotics and may also have audio capability. Stills may be in the form of dioramas.

Cathode ray tubes (CRT) and liquid crystal displays (LCD), purely 2D displays, may be used as virtual objects, as indicated at 58 and 60, respectively, in Figure 4, and these displays,of course, may possess any content which a computer or other electronic source (video cassette player for example) is capable of generating. In these cases, it may be desirable to depart from 1:1 imaging, since it will usually be desirable to produce a real image larger than the CRT or LCD being imaged. Multiple displays may be used, as indicated at 62 in Figure 4.

Three-dimensional effects are made possible through the use of dynamic or still interlaced images in combination with lenticular screens (shown at 64) that themselves can be either 2D or linear arrays of cylindrical lenses. For an example of the type of lenticular screens that may be employed, reference may be had to United

States Patent Nos. 5,588,526 and 5,647,151 which are incorporated herein by reference for their teaching of the design and fabrication of lenticular screens for use with interlaced images.

Where still 3D images are contemplated, interlaced images are generated on printed artwork and placed at or near the focal plane of a lenticular array, as indicated at 66. Where dynamic or animated or changing 3D or alternating images are to be projected, a CRT or LCD is used as the source of the interlaced images along with a lenticular array 64. Where 3D images are to be projected, it will be recognized that these are autostereoscopic so that a customer sees projected images in 3D, without the need for visual aids.

Other enhancements which may be included in optical projections systems such as those shown in Figures 1 to 3, include an audio module 68 (Figure 3) for adding sound to the projected image, a motion/position detector 70 for sensing the presence and/or position of a customer with respect to the advertising system and, in response, controlling the content of the projected images/sound as a function of the customer's location. An interactive module 72 capable of receiving one or more inputs from a customer can be used to permit a customer to engage the advertising system in conversation or other two-way communications intended to respond to customer queries. This may be accomplished using suitable voice recognition software or touch screens or other well-known means by which a person may select among options presented to him or her. The system may also be provided with the capability of recognizing commonly asked questions and responding to them by answering with stock answers.

If touch screens or similar devices are to be used, it will be seen, for example from Figure 1, that the typical overhead location of the system will often render it impracticable to locate the touch screen or similar input device directly on the system itself, since this will be out of reach of the customer. Instead, the touch screen could be located adjacent or on the cabinets 12 (Figure 1) and communicate with the system via conventional radio, ultrasonic or infrared communication devices such as are well known to those skilled in data communication technology. Indeed, one could

equip a supermarket cart 24 (Fig. 1) with an appropriate touch screen or similar device, so enabling the cart to query any adjacent projection system.

From the foregoing, it will be seen that the full range of outputs from systems such as those shown in Figure 4 might include:

(a) 3D objects, with and without sound;

(b) 3D animations with and without sound;

(c) stereo images with and without sound;

(d) projected displays with and without sound

(e) multimedia presentations;

(f) interactive advertising; and

(g) hybrid combinations of any of the above.

Other possible architectures for the advertising system are shown in Figures 5, 6 and 7. The systems shown in these Figures are arranged to simultaneously project real images in a plurality of directions angularly separated from one another. More specifically, the system shown in Figures 5 and 6 is arranged to project two real images in opposed directions. As best seen in Figure 6, this system, generally designated 80, comprises two similar modules 82 and 84 arranged back-to-back. Each module 82 and 84 resembles the system shown in Figure 3, but only one deflecting mirror 86 or 88 is used. Also, as compared with the system shown in Figure 3, the modules 82 and 84 are rotated 90° about a horizontal axis so that the object generation module 90 or 92 is at the upper end of the system, and light from this object passes through a horizontally-disposed Fresnel lens 94 or 96, and is deflected through 90° by the mirror 86 or 88, so that it leaves the module via a vertically-disposed Fresnel lens 98 or 100.

The system (generally designated 102) shown in top plan view in Figure 7 comprises three separate modules 104, 106 and 108, each of which is essentially identical to the modules 82 and 84 shown in Figures 5 and 6. However, the modules 104, 106 and 108 are arranged so that three real images are projected at 120° to each other, towards the vertices of an equilateral triangle.

It will readily be apparent that the systems shown in Figures 5, 6 and 7 can be modified to provide differing numbers of projected images, for example four images at 90° intervals, or six images at 60° intervals. Also, if desired such systems could be made movable; for example, the system shown in Figure 7 could be rotated about its central vertical axis to display a succession of differing images to customers.

Figure 8 shows schematically an advertising system (generally designated 110) which uses an LCD projector 112 as an object generator; this projector is switchable between inverted and reverted image orientations. The general arrangement of the system 110 is similar to that of the system shown in Figure 3 in that the light from the projector 112 is deflected successively by first and second mirrors 114 and 116, respectively; each mirror deflecting the light through a right angle so that the light is reversed in direction. However, in the system 110, a screen 118 (which may have the form of a conventional diffusion screen, e.g., Mylar, but is preferably a field lens with mild diffusion) is arranged to receive light leaving the second mirror 116 so that an intermediate image is formed on this screen 118. A pair of identical Fresnel lens 120 and 122, perferably of symmetric form, are arranged touching each other, with their Fresneled surfaces arranged with respect to one another for optimal imaging performance. Fresnel lenses 120 and 122 are spaced from the screen 118 by a distance equal to approximately twice the effective focal length of the combined Fresnel lenses. The two Fresnel lens together form a real image in space at a distance of approximately two focal lengths from the Fresnel lens, thus reproducing the image formed on the intermediate screen 118 at 1:1 magnification. Other magnifications may be provided by appropriate placement of the Fresnel lens pair with respect to the screen 118. It will be appreciated that function of Fresnel lenses, 114 and 116, may be provided by suitable conventional refracting elements with spherical or more complex surfaces as needed or a single element having one or both surfaces in the form of a Fresnel.

Finally, it is contemplated that individual advertising systems be networked into systems (LANs or WANs) or otherwise linked so that each may be sent preselected programs of the same or different content that may be periodically changed or updated or enhanced. Communications of these programs may be by any well-

known means such as infrared or microwave or hardwire links, and they may be downloaded directly to a network server via the Internet or via telephone lines from a central computer or be provided on storage media.

It will be apparent to those skilled in the art that numerous changes and variations can be made in the specific embodiments of the invention described above without departing from the scope of the present invention. Accordingly, the foregoing description is to be construed in an illustrative and not in a limitative sense, the scope of the invention being defined solely by the appended claims.

What I claim is:

1. An optical projection system for use in advertising in a retail establishment, the projection system comprising:

a housing;

an object generation module disposed within said housing and comprising an object the image of which is to be projected; and

a relay module arranged within said housing and comprising an optical system arranged to project a real image of said object outside and spaced from said housing, said real image being visible only from a limited area adjacent said housing and over a limited angle of view.

2. An optical projection system according to claim 1 wherein said housing is provided with mounting means by which said projection system can be mounted above and spaced from the floor of a building.

3. An optical projection system according to claim 2 wherein said mounting means is formed so that said projection system projects said real image downwardly towards a person standing below said housing.

4. An optical projection system according to claim 1 wherein said optical projection system comprises an output Fresnel lens disposed at the output end of said optical system closest to said real image.

5. An optical projection system according to claim 4 wherein said optical projection system further comprises an input Fresnel lens disposed at the input end of said optical projection system closest to the object generation module, said input Fresnel lens being spaced from said output Fresnel lens by an optical path distance greater than the focal length of either Fresnel lens, said optical system also comprising a field aperture disposed between the two Fresnel lenses.

6. An optical projection system according to claim 5 wherein said optical projection system further comprises first and second mirrors disposed in the optical path between said input and output Fresnel lenses, each of said mirrors being arranged to deflect light passing from said input to said output Fresnel lenses by

approximately a right angle, so that light from the input Fresnel lens is deflected by approximately 180° before reaching said output Fresnel lens.

7. An optical projection system according to claim 1 wherein said optical system comprises:

a first diffusion means arranged to receive a first image of said object;

a first Fresnel lens spaced from said first diffusion means by a distance greater than its focal length, said first Fresnel lens being arranged to receive light from said first image; and

a second Fresnel lens disposed adjacent said first Fresnel lens and forming said real image.

8. An optical projection system according to claim 7 wherein said optical system further comprises:

a first mirror arranged to receive light from said object and to deflect said light by approximately a right angle; and

a second mirror arranged to receive light from the first mirror and to deflect said light by approximately a right angle on to said diffusion means.

9. An optical projection system according to claim 7 wherein said object comprises a liquid crystal display projector.

10. An optical projection system according to claim 1 wherein said object comprises any one or more of:

(a) a static three-dimensional object;

(b) an animated three-dimensional object;

(c) two-dimensional artwork;

(d) a two-dimensional screen provided with means for forming variable images thereon;

(e) projector means for forming variable images;

(f) any one of (c), (d) and (e) above provided with a lenticular screen for rendering the image produced autostereoscopic.

11. An optical projection system according to claim 10 wherein said two-dimensional screen comprises a liquid crystal display projector.

12. An optical projection system according to claim 1 further comprising sound output means for outputting sound to a customer viewing said real image.

13. An optical projection system according to claim 1 further comprising customer input means for receiving at least one input from a customer viewing said real image, and image variation means for varying said real image in response to the input received by said customer input means.

14. A retail establishment having a retail area accessible to customers, said retail area being provided with at least one optical projection system, said system comprising:

a housing;

an object generation module disposed within said housing and comprising an object the image of which is to be projected; and

a relay module arranged within said housing and comprising an optical system arranged to project a real image of said object outside and spaced from said housing, said real image being visible only from a limited portion of said retail area adjacent said housing and over a limited angle of view.

15. A retail establishment according to claim 14 wherein said housing of said optical projection system is mounted above and spaced from the floor of the retail area, and is arranged to projects said real image downwardly towards a person standing below said housing on the floor of the retail area.

16. A retail establishment according to claim 14 having at least two of said optical projection systems arranged to that the limited portions of said retail area from which the real images produced by said optical projection systems are visible do not overlap, so that only one of said real images is visible to any customer at any one time.

17. A retail establishment according to claim 14 wherein said optical system comprises an output Fresnel lens disposed at the output end of said optical system closest to said real image.

18. A retail establishment according to claim according to claim 17 wherein said optical system further comprises an input Fresnel lens disposed at the input end of said optical system closest to the object generation module, said input Fresnel lens being spaced from said output Fresnel lens by an optical path distance greater than the focal length of either Fresnel lens, said optical system also comprising a field aperture disposed between the two Fresnel lenses.

19. A retail establishment according to claim 18 wherein said optical system further comprises first and second mirrors disposed in the optical path between said input and output Fresnel lenses, each of said mirrors being arranged to deflect light passing from said input to said output Fresnel lenses by approximately a right angle, so that light from the input Fresnel lens is deflected by approximately 180° before reaching said output Fresnel lens.

20. A retail establishment according to claim 14 wherein said optical system comprises:

a first diffusion means arranged to receive a first image of said object;

a first Fresnel lens spaced from said first diffusion means by a distance greater than its focal length, said first Fresnel lens being arranged to receive light from said first image; and

a second Fresnel lens disposed adjacent said first Fresnel lens and forming said real image.

21. A retail establishment according to claim 20 wherein said optical system further comprises:

a first mirror arranged to receive light from said object and to deflect said light by approximately a right angle; and

a second mirror arranged to receive light from the first mirror and to deflect said light by approximately a right angle on to said diffusion means.

22. A retail establishment according to claim 20 wherein said object comprises a liquid crystal display projector.

23. A retail establishment according to claim 14 wherein said object comprises any one or more of:

(g) a static three-dimensional object;

(h) an animated three-dimensional object;

(i) two-dimensional artwork;

(j) a two-dimensional screen provided with means for forming variable images thereon;

(k) projector means for forming variable images;

(l) any one of (c), (d) and (e) above provided with a lenticular screen for rendering the image produced autostereoscopic.

24. A retail establishment according to claim 14 wherein said optical projection system further comprises sound output means for outputting sound to a customer viewing said real image.

25. A retail establishment according to claim 14 wherein said optical projection system further comprises customer input means for receiving at least one input from a customer viewing said real image, and image variation means for varying said real image in response to the input received by said customer input means.

26. A network of optical projection systems for use in advertising in a retail establishment, said network comprising at least one projection system comprising:

a housing;

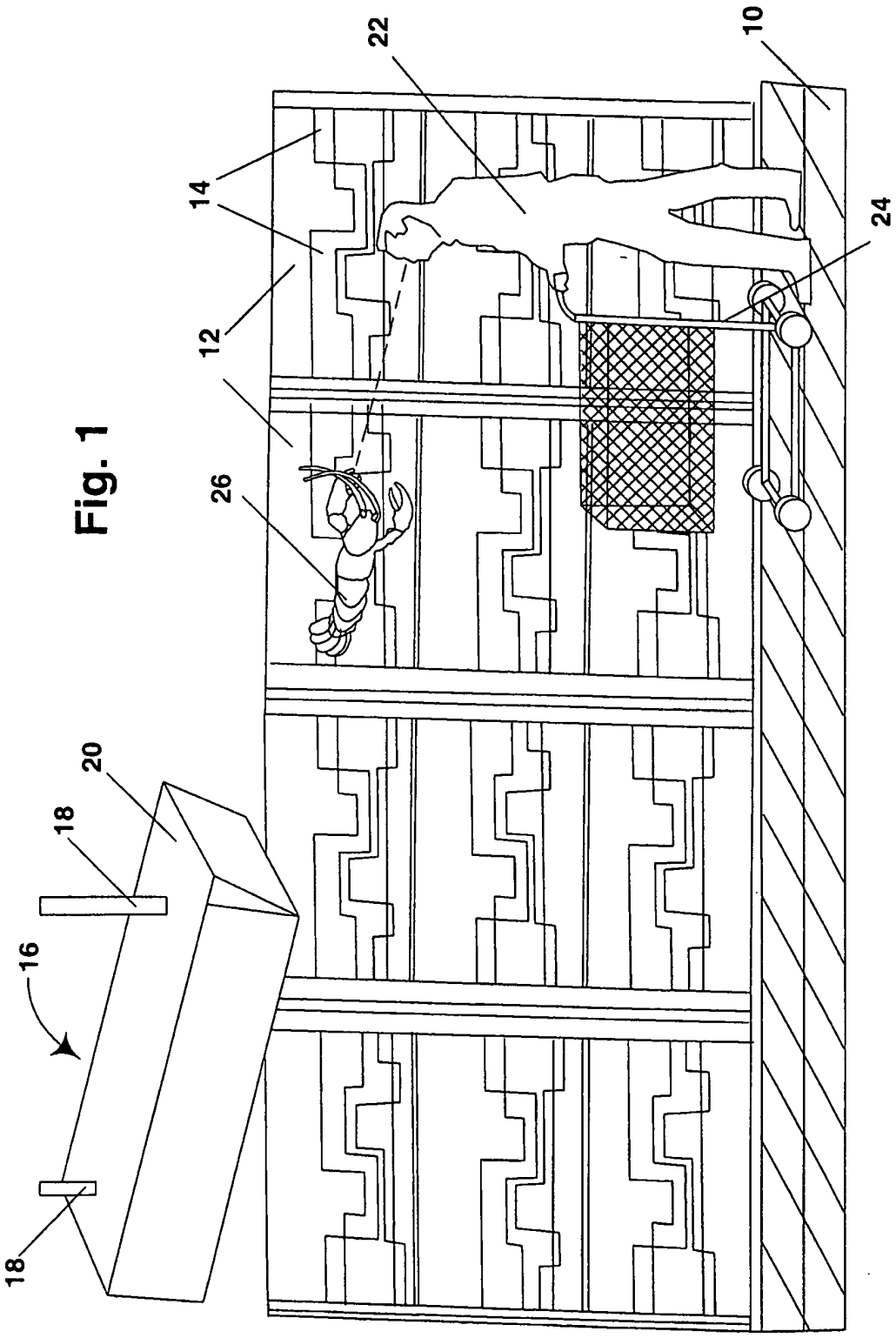
an object generation module disposed within said housing and comprising an object the image of which is to be projected; and

a relay module arranged within said housing and comprising an optical system arranged to project a real image of said object outside and spaced from said housing, said real image being visible only from a limited area adjacent said housing and over a limited angle of view.

27. The network of claim 26 further including server means for communicating with one or more projection systems within said network and facilitating communications between said projection systems.

28. The network of claim 27 further including linking means for connecting said server means and said projection systems, said linking means being selected from the group consisting microwave, infrared, and hardwire links.

Fig. 1



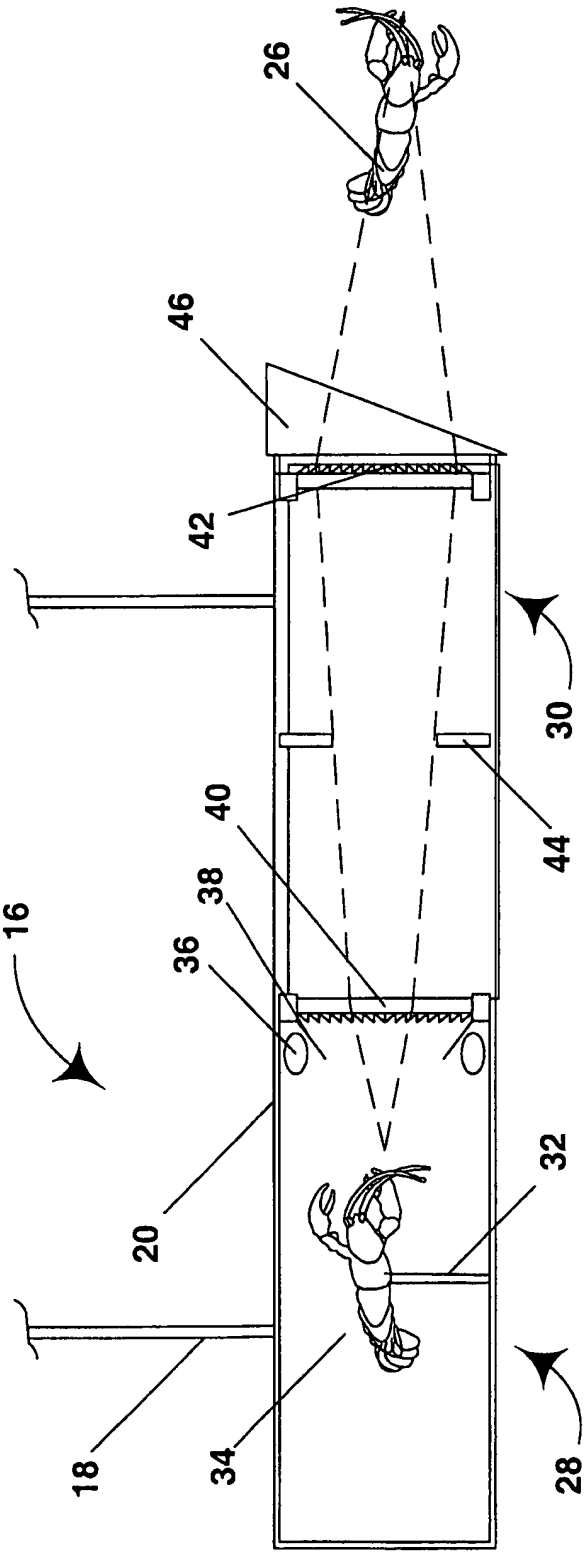


Fig. 2

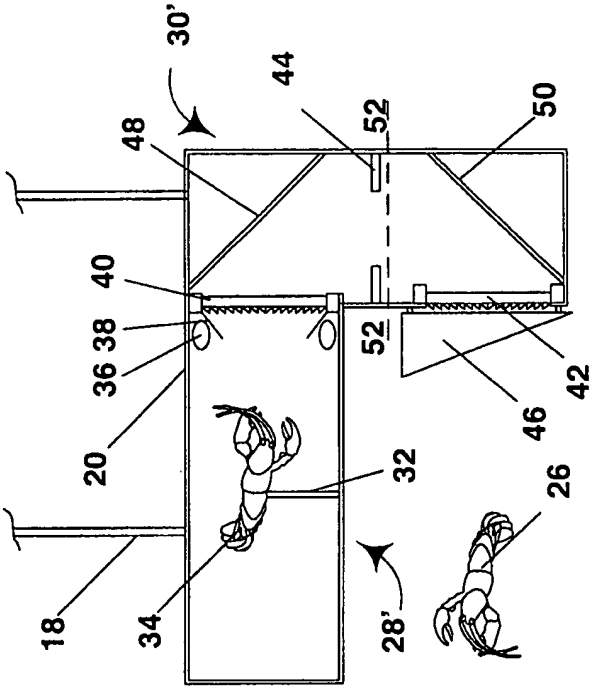


Fig. 3

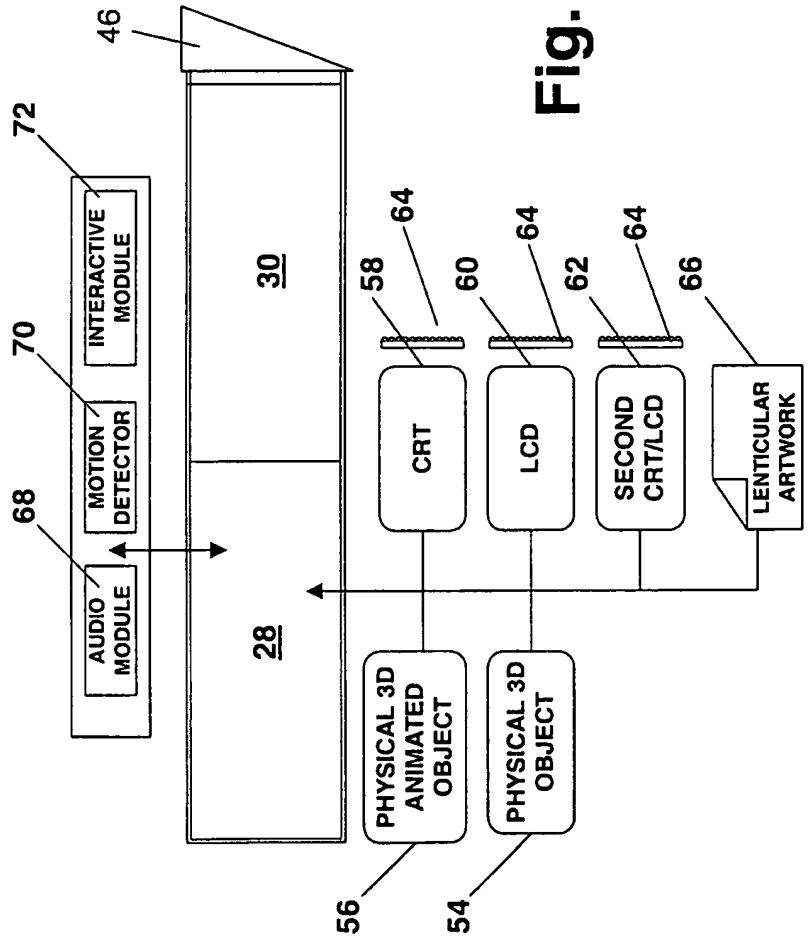

46
72
INTERACTIVE MODULE
70
MOTION DETECTOR
68
AUDIO MODULE
30
28
64
58
60
64
62
64
66
CRT
LCD
SECOND CRT/LCD
LENTICULAR ARTWORK
PHYSICAL 3D ANIMATED OBJECT
PHYSICAL 3D OBJECT
56
54

Fig. 4

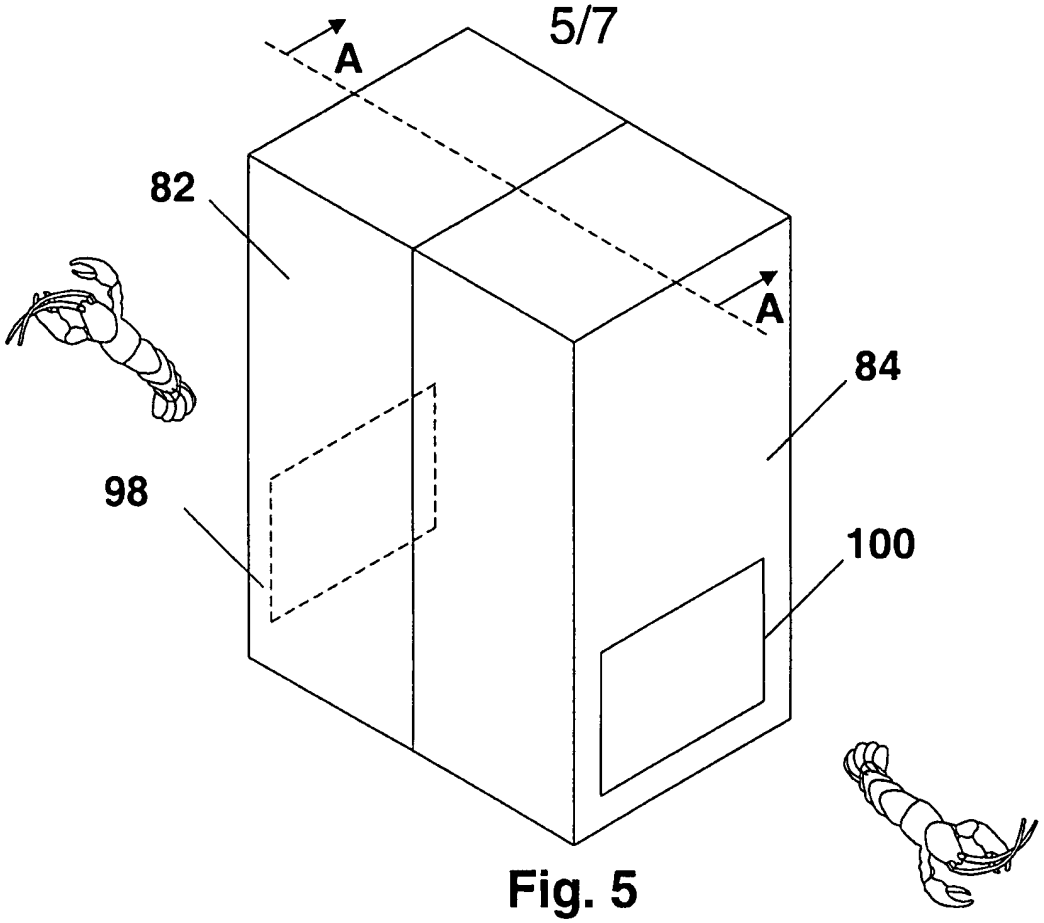


Fig. 5

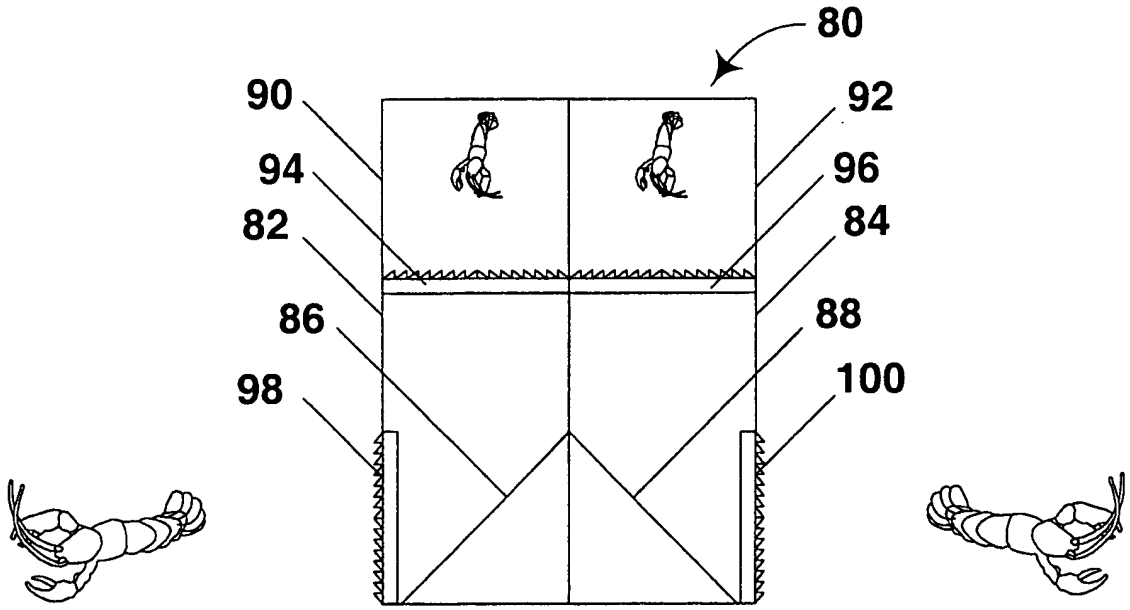


Fig. 6

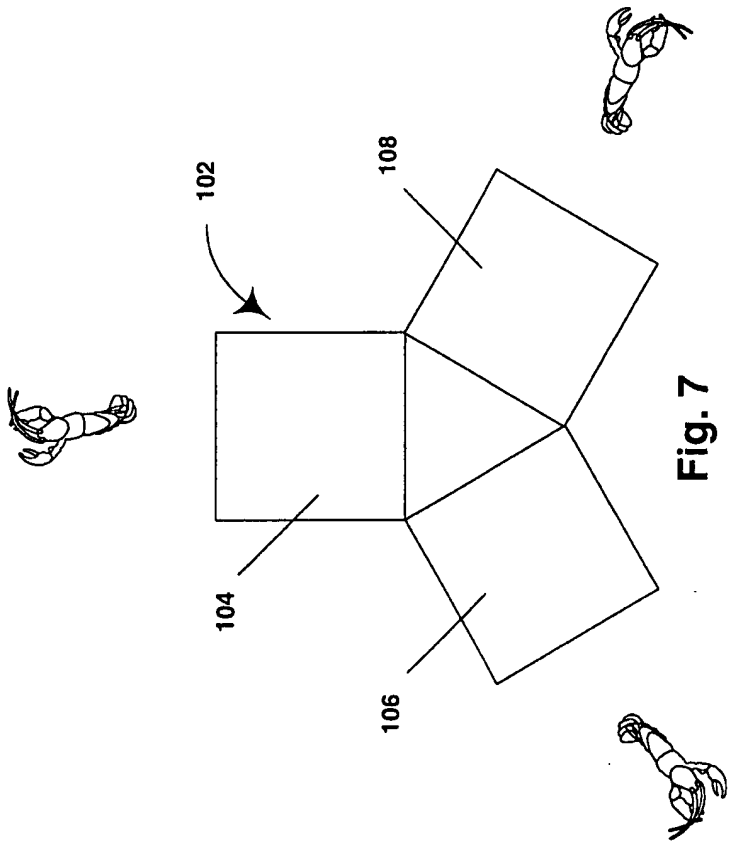


Fig. 7

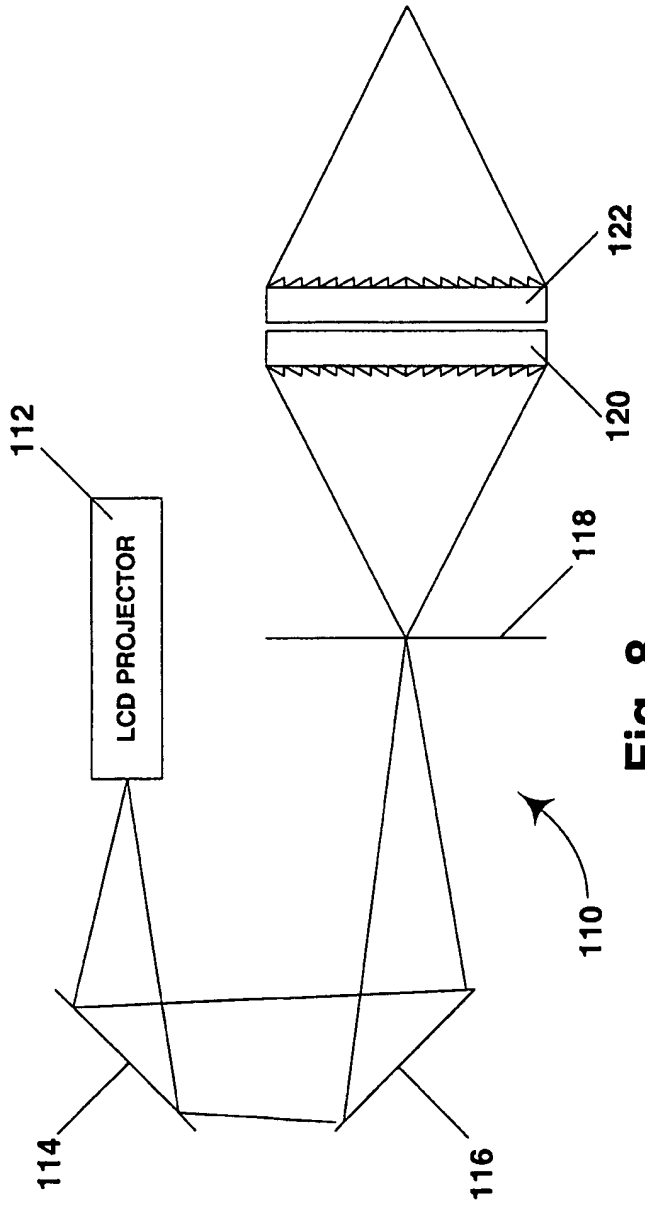


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/04994

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :G03B 21/14
US CL : 353/10, 28; 359/478
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 353/10, 28; 359/478

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,671,625 A (Noble) 09 June 1987 (09.06.87) See entire document	1,4,10,14,17,23,26 --- 2-3,7-9,11-13,15-16,18-17,20-22,24-25,27-28
A,P	US 5,782,547 A (MACHTIG ET AL.) 21 JULY 1998 (21.07.98) See entire document	1-28
A,E	US 5,886,818 A (SUMMER ET AL.) 23 March 1999 (23.03.99) See entire document	1-28
A	US 5,311,357 A (SUMMER ET AL.) 10 MAY 1994 (10.05.94) See entire document	1-28

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
19 MAY 1999	02 JUN 1999

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	WILLIAM C. DOWLING
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Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/04994

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	US 5,795,228 A (TRUMBULL ET AL.) 18 AUGUST 1998 (18.08.98) See entire document	11-13, 22, 24-25